

Attorney Docket No.: 071469-0305914
Client Reference: RAJ-007

IN THE DRAWINGS:

Submitted herewith is attached a Replacement Sheet of Drawing that is intended to replace the original filed drawing sheet.

Attachment: One (1) Replacement Sheet (Figures 6A & 6B).

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REMARKS

Claims 1, 17, 38, and 74 are amended hereby. No claims are canceled or newly added. Accordingly, after entry of this Amendment, claims 1-6, 8-20, 22, 24-26, 28-41, 43-55, 57, 59-61, and 63-82 will remain pending.

In the Office Action, the Examiner acknowledged the Applicant's traversal of the Requirement for Election of Species. However, the Examiner found that the arguments were not found to be persuasive. Accordingly, the Examiner made the election final. All of claims 1-6, 8-20, 22, 24-26, 28-41, 43-55, 57, 59-61, and 63-82 read on the elected species. Accordingly, all of the claims remain under examination. The Applicant respectfully submits that, due to the amendments presented herein, a generic claim has been established for all of the species. Accordingly, the Applicant respectfully submits that claims 1-6, 8-20, 22, 24-26, 28-41, 43-55, 57, 59-61, and 63-82 should now be in a condition for allowance, thereby rendering moot the Requirement for Election of Species.

In the Office Action dated October 10, 2006, the Examiner objected to Fig. 6A as being difficult to read. In response, the Applicant provides a replacement for Fig. 6A with this Amendment. The Applicant believes that this replacement sheet provided herewith addresses the objection by the Examiner. Accordingly, the Applicant respectfully requests that the Examiner withdraw the objection to Fig. 6A.

In the Office Action, the Examiner rejected claims 37 and 74 under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter that the Applicant regards as the invention. In response, the Applicant respectfully submits that claims 37 and 74 have been amended to recite "a high-k material." The Applicant respectfully submits that this clarification overcomes the rejection under 35 U.S.C. § 112, second paragraph. Accordingly, the Applicant respectfully requests that the Examiner withdraw the rejection.

In the Office Action, the Examiner rejected claims 1-3, 5-6, 8-13, 15, 17-20, 22, 24-26, 28-33, 36-38, 40-41, 43-48, 50, 52-55, 57, 59-61, and 73-74 under 35 U.S.C. § 102(e) as being anticipated by Chung et al. (U.S. Patent Application Publication No. 2003/0203616). Claims 4, 39, and 70 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Chung et al. In addition, the Examiner rejected claims 14, 34-35, 49, 71-72, and 75-82 under 35 U.S.C. § 103(a) as being unpatentable over Chung et al. in view of Lai et al. (U.S. Patent No. 6,939,804). Finally, claims 16 and 51 were rejected under 35 U.S.C. § 103(a) as being

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unpatentable over Chung et al. in view of Elers et al. (U.S. Patent Application Publication No. 2002/0187256). The Applicant respectfully disagrees with each of these rejections and, therefore, respectfully traverses the same.

In response, the Applicant respectfully submits that all of claims 1-6, 8-20, 22, 24-26, 28-41, 43-55, 57, 59-61, and 63-82 are patentable over the references cited by the Examiner because they recite a method of depositing a metal layer on a substrate (claim 1) or a method of depositing a W layer on a substrate (claim 38) that combines a number of features including, among them, performing a sequential deposition cycle that includes: first, exposing the substrate to a metal-carbonyl precursor gas (claim 1) or a $W(CO)_6$ precursor gas (claim 38) to deposit a thickness greater than 5 angstroms of a metal layer (claim 1) or a W layer (claim 38) on the substrate in each deposition cycle, wherein the substrate is maintained at a substrate temperature that results in thermal decomposition of the metal-carbonyl precursor gas (claim 1) or a $W(CO)_6$ precursor gas (claim 38), and second, exposing the metal layer (claim 1) or the W layer (claim 38) to a reducing gas. None of the references describe or suggest at least this combination of features. Accordingly, the Applicant respectfully submits that all of claims 1-6, 8-20, 22, 24-26, 28-41, 43-55, 57, 59-61, and 63-82 are patentable thereover.

In making this amendment, the Applicant respectfully submits that there are at least two features that distinguish the present invention from the prior art. First, the deposition cycle is sequential, meaning that the substrate is exposed to a metal-carbonyl precursor gas (claim 1) or a $W(CO)_6$ precursor gas (claim 38) and then is exposed to a reducing gas. Second, when exposing the substrate to the metal-carbonyl precursor gas (claim 1) or the $W(CO)_6$ precursor gas (claim 38), a metal layer with a thickness greater than 5 angstroms is deposited in each deposition cycle. None of the references, either alone or in combination recite at least this combination of features. Moreover, while the Applicant discusses these two features herein for purposes of distinguishing the claims from the prior art, the Applicant does not wish to infer that these two features are the only features that distinguish the present invention from the prior art. The contrary is, in fact, true.

Chung et al. describes an atomic layer deposition of tungsten barrier layers using tungsten carbonyls and boranes for copper metallization. Fig. 2 of Chung et al. is helpful in understanding how Chung et al. differs from the present invention. As noted, at step 104, a carrier gas stream is established within the process chamber. (Chung et al. at paragraph [0029].) At step 106, tungsten carbonyl is subsequently added, in a pulse, in a sufficient

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amount, for at least a monolayer of the tungsten carbonyl compound to be adsorbed on the substrate. (Chung et al. at paragraph [0031].) At step 107, a purge gas is provided to flush excess tungsten carbonyl from the process chamber. (Chung et al. at paragraph [0032].) Then, at step 108, a borane compound is added to the carrier stream so that at least a monolayer of borane compound is adsorbed on the tungsten carbonyl compound. (Chung et al. at paragraph [0033].) The amount of borane is preferably in excess of the amount required for complete conversion of the tungsten carbonyl to tungsten. (Chung et al. at paragraph [0033].) The thickness of the tungsten layer is described in paragraph [0046], where Chung et al. states that 30 cycles of the process results in a tungsten thickness of 30 Å, thereby leading those skilled in the art to conclude that each cycle results in the creation of a tungsten layer that is about 1 Å thick.

As is immediately apparent from the synopsis provided above, there are at least two distinctions that the Applicant would like to make with respect to Chung et al. First, exposing the substrate to tungsten carbonyl results in the formation of a layer of tungsten carbonyl on the surface of the substrate, not metallic tungsten. Second, the thickness of the tungsten layer created at the conclusion of each cycle is 1 Å, which is not greater than 5 Å, as recited by the claims now being examined. As a result, there are at least two features of claims 1 and 38 that are not described by Chung et al. Since the reference does not describe each and every feature recited by claims 1 and 38, Chung et al. cannot be relied upon to anticipate those claims. As a result, Chung et al. cannot be relied upon to anticipate any of the remaining claims that depend from claims 1 and 38.

Lai et al. does not assist the Examiner with a rejection of any of the claims. Lai et al. describes the formation of composite tungsten films. Fig. 6 is representative of the processing cycle. As discussed, the method of forming a composite tungsten film involves the deposition of a tungsten nucleation layer followed by the formation of a tungsten bulk layer on the nucleation layer. (Lai et al. at col. 5, lines 54-57.) The tungsten nucleation layer may be formed using a cyclical deposition process by alternately adsorbing a tungsten-containing precursor and a reducing gas on the substrate. (Lai et al. at col. 5, lines 58-61.) The tungsten precursor may be tungsten hexafluoride (WF₆) or tungsten carbonyl (W(CO)₆). (Lai et al. at col. 6, lines 40-46.) The thickness of the nucleation layer typically is less than 100 Å, preferably between 15 Å and 50 Å. (Lai et al. at col. 6, lines 10-14.) As discussed in connection with tungsten hexafluoride, the deposition rate for the tungsten nucleation layer of about 1.1 Å/cycle. (Lai et al. at col. 10, lines 16-19.)

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The Applicant respectfully submits that Lai et al. does not cure the deficiencies noted with respect to Chung et al. Like Chung et al., Lai et al. describes a cyclical process where the tungsten precursor is adsorbed on the substrate. A metal layer is not deposited. Like Chung et al., the thickness of layer of tungsten precursor is about 1 Å, which is less than the "greater than 5 Å" recited by claims 1 and 38. Accordingly, the Applicant respectfully submits that neither Chung et al. nor Lai et al. describes or suggests the methods recited by claims 1 and 38. Moreover, at least for the same reasons, the two references do not describe or recite the features added by the dependent claims. At least for these reasons, therefore, the Applicant respectfully submits that Chung et al. and Lai et al. cannot be relied upon to render obvious any of the claims being examined in this application.

Ehlers et al. does not assist the Examiner with a rejection of the claims because it also fails to describe or suggest any of the features that are absent from Chung et al. or Lai et al.

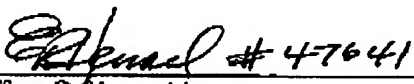
In summary, the Applicant respectfully submits that claims 1-6, 8-20, 22, 24-26, 28-41, 43-55, 57, 59-61, and 63-82 are neither anticipated nor rendered obvious by any of the references relied upon by the Examiner. In view of the foregoing, therefore, the Applicant respectfully request consideration and allowance of the present application.

If there are any fees required for this submission that are not otherwise accounted for, please charge any fees such associated with the submission of this paper to Deposit Account Number 033975. The Commissioner for Patents is also authorized to credit any over payments to the above-referenced Deposit Account.

Respectfully submitted,

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